

# **Clean Air Status and Trends Network**

## **Second Quarter 2002 Data Report**

### **(April – June 2002)**

Prepared for:  
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## Summary of Quarterly Operations

### Introduction

This quarterly report summarizes the Clean Air Status and Trends Network (CASTNet) data collected during the second quarter 2002. The data presented in this report are based on data validated at both Level I and Level II (Table 1). Results from the quality assurance/quality control (QA/QC) program are presented for second quarter data for filter concentrations only. Data completeness and QC statistics are not presented for the continuous measurements because of the mixture of Level I and Level II validation results. This report presents information on air pollutant concentrations collected from the dry deposition samplers. Ozone ( $O_3$ ) concentrations are also presented. The report is accompanied by a data submittal that includes the following second quarter data: summaries of calibration results, laboratory data and laboratory comments, and continuous data validation transactions. Also included are updated versions of the DRYCHEM\_SUMMARY, EQUIPMENT\_INVENTORY, METDATA\_SUMMARY, and SITE\_OPERATORS tables.

### Data Presentation

Air quality measurements collected during second quarter 2002 are summarized. First, mean concentrations from CASTNet filter packs are presented in Figures 1 through 10. Concentration data presented in Figures 1 through 6 include sulfur dioxide ( $SO_2$ ), particulate sulfate ( $SO_4^{2-}$ ), nitric acid ( $HNO_3$ ), particulate ammonium ( $NH_4^+$ ), particulate nitrate ( $NO_3^-$ ), and total nitrate ( $HNO_3$  plus  $NO_3^-$ ). Concentration data for the four cations, particulate calcium ( $Ca^{2+}$ ), particulate potassium ( $K^+$ ), particulate magnesium ( $Mg^{2+}$ ), and particulate sodium ( $Na^+$ ), are presented in Figures 7 through 10. In addition, quarterly means derived from second quarter measurements from 1990 through 2002 are analyzed for trends and shown in Figures 11 through 16. Finally,  $O_3$  concentrations through second quarter 2002 are presented in Figures 17 and 18. The various data presentations and data analyses are based on some data that have been validated at Level I. Consequently, the data and related analyses are subject to change during the Level II validation process.

#### ***Concentrations from Filter Packs***

Figure 1a presents mean  $SO_2$  concentration data for both second quarter 2002 and second quarter 2001. The second quarter 2002  $SO_2$  concentrations show a region with values of 5.0 or more micrograms per cubic meter ( $\mu g/m^3$ ) north of the Ohio River and extending northeastward from Indiana across Pennsylvania into Maryland. The single highest quarterly mean concentration ( $14.1 \mu g/m^3$ ) was measured at Quaker City, OH (QAK172). Figure 1b shows the percent difference between 2002 and 2001 second quarter  $SO_2$  concentrations [i.e.,  $(2002-2001)/2001$ ]. Positive values indicate increases in concentrations. The CASTNet measurements show significant decreases in quarterly mean  $SO_2$  concentrations across most of the eastern United States. Only a few sites in western North Carolina, Georgia, Alabama, Florida, New York, and Michigan observed higher levels during the second quarter of 2002. The western sites showed a mixture of increases and decreases.

Quarterly mean  $\text{SO}_4^{2-}$  concentrations for both second quarter 2002 and second quarter 2001 are shown in Figure 2a. The percent difference between 2002 and 2001 second quarter  $\text{SO}_4^{2-}$  concentrations is shown in Figure 2b. Second quarter 2002 concentrations show a large region with values above  $5.0 \mu\text{g}/\text{m}^3$ . This region is bounded by eastern Tennessee and western North Carolina in the south and by Indiana, Ohio, and Pennsylvania in the north. The single highest quarterly mean sulfate concentration ( $6.7 \mu\text{g}/\text{m}^3$ ) was measured at QAK172. A large majority of CASTNet sites observed declines in quarterly mean  $\text{SO}_4^{2-}$  concentrations. Central California is an exception – four sites measured higher mean concentrations.

Quarterly mean  $\text{HNO}_3$  concentrations for both second quarter 2002 and second quarter 2001 are shown in Figure 3a. Figure 3b shows the percent difference between 2002 and 2001 second quarter concentrations. Eastern CASTNet sites recorded a mixture of increases and decreases. All but one western site measured higher concentrations.

Quarterly mean  $\text{NH}_4^+$  concentrations for both second quarter 2002 and second quarter 2001 are presented in Figure 4a. All but nine eastern sites measured lower concentrations in second quarter 2002 versus 2001 (Figure 4b). Approximately two thirds of the western sites measured increases in second quarter mean  $\text{NH}_4^+$  concentrations.

Quarterly mean  $\text{NO}_3$  concentrations for both second quarter 2002 and second quarter 2001 are shown in Figure 5a. A map of differences is shown in Figure 5b. All but six eastern sites observed decreased quarterly mean concentrations between second quarter 2001 and 2002. All but a few western sites observed higher particulate  $\text{NO}_3$  concentrations during the second quarter 2002.

Observed quarterly mean total nitrate concentrations for both second quarter 2002 and second quarter 2001 are shown in Figure 6a. The measurements show a relatively narrow region extending from Illinois northeastward through Ohio with quarterly mean concentrations above  $4.0 \mu\text{g}/\text{m}^3$ . Four sites in southern California observed concentrations with a magnitude of  $2.0 \mu\text{g}/\text{m}^3$  or greater. Joshua Tree National Monument (JOT403) recorded the single highest quarterly mean concentration of  $6.2 \mu\text{g}/\text{m}^3$ . The pattern of concentration changes, as shown in Figure 6b, exhibits decreases in total nitrate measurements at most eastern sites. The site at Cranberry, NC (PNF126) recorded a 60.8 percent increase to  $3.7 \mu\text{g}/\text{m}^3$  for the same quarter in 2002. The western sites showed a majority of sites with higher concentrations.

Quarterly mean concentrations of  $\text{Ca}^{2+}$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ , and  $\text{Na}^+$  are shown in Figures 7 through 10. Two geographic patterns are evident from the four maps. First, the majority of the highest  $\text{Ca}^{2+}$  concentrations were measured in the Midwest from northern Tennessee northward to Ontario. The map in Figure 7 shows a large region with concentrations above  $0.30 \mu\text{g}/\text{m}^3$ . The site at Vincennes, IN (VIN140) recorded the highest concentration of  $1.21 \mu\text{g}/\text{m}^3$ . Concentrations above  $0.30 \mu\text{g}/\text{m}^3$  were also measured along the coastal plain from Florida to North Carolina. Twelve western sites observed  $\text{Ca}^{2+}$  concentrations above  $0.30 \mu\text{g}/\text{m}^3$  with the highest value ( $1.16 \mu\text{g}/\text{m}^3$ ) at the new site at Konza Prairie, KS (KNZ184). Figure 10 shows that the highest  $\text{Na}^+$  concentrations were measured on or near the coastal plain. Concentrations above  $1.00 \mu\text{g}/\text{m}^3$  were observed in Florida northward to North

Carolina. The highest  $\text{Na}^+$  concentration ( $2.89 \mu\text{g}/\text{m}^3$ ) was measured at the coastal site at Indian River Lagoon, FL (IRL141).

### ***Trends***

In this quarterly report, trend analyses have been performed based on pollutant concentrations averaged over the 34-station subset of the eastern CASTNet sites used for trend analyses in the CASTNet 2000 Annual Report (Harding ESE, 2002a). The 34-station composite quarterly means shown in Figures 11 through 16 are plotted versus the year from 1990 through 2002. The trends were calculated for second quarter values.

Figure 11 shows the trend in second quarter composite  $\text{SO}_2$  concentrations and Figure 12 shows the trend in  $\text{SO}_4^{2-}$  concentrations for the 34 sites. The aggregated  $\text{SO}_2$  and  $\text{SO}_4^{2-}$  data show overall downward trend with a major decline in 1995, which resulted from the Phase I electric utility  $\text{SO}_2$  emission reductions. No significant change is evident after 1995. The 2002 data show a decline from 2001.

Trend analyses were also performed on composite second quarter mean  $\text{HNO}_3$ ,  $\text{NH}_4^+$ ,  $\text{NO}_3^-$ , and total  $\text{NO}_3^-$  concentrations collected during the period 1990 through 2002. The results given in Figures 13 through 16 show no overall trends, although the data for  $\text{NH}_4^+$  show a slight decline.

### **Ozone Concentrations**

Figure 17 shows the number of days with hourly ozone concentrations greater than or equal to 125 parts per billion (ppb) in the first and second quarters of 2002. Two eastern sites, Beltsville, MD (BEL116) and Abington, CT (ABT147), and one western site, JOT403 in California, which is located downwind of Los Angeles, experienced days with elevated hourly  $\text{O}_3$  concentrations.

Figure 18 provides a map of the fourth highest daily maximum eight-hour  $\text{O}_3$  concentrations measured in the first two quarters of 2002. Fourteen eastern sites and two locations in California show values above 85 ppb. The highest 8-hour concentrations were observed along the Washington, D.C. - Boston corridor and in the Midwest from Illinois to northwestern Pennsylvania. Sites at Great Smoky Mountains National Park, TN (GRS420) and at Candor, NC (CND125) also measured 8-hour values above 85 ppb. The two sites in California included Sequoia National Park (SEK402) and JOT403. Some of these  $\text{O}_3$  measurements are validated at Level I (Table 1) and are subject to change during the validation process. Final data will be presented in the CASTNet 2002 Annual Report.

## **Results of the QA/QC Program**

### ***Completeness***

Data completeness statistics are presented for dry deposition (concentration) measurements only. Completeness data for the continuous measurements are not presented since the second quarter 2002 database consists of data validated at both Level I and Level II. However, completeness data for the filter concentrations for second quarter

2002 are presented in Table 2 even though the concentrations include both Level I and Level II measurements because, historically, completeness statistics for filter concentrations show almost no change from Level I data to Level II data. Average data capture exceeded 95 percent. Five sites listed in Table 2 had data completeness for filter concentrations with less than 90 percent recovery. The site at Huntington Forest, NY (HWF187) began operation late during the second quarter (5/28/02). The site at Prince Edward, VA (PED108) had no valid data due to persistent flow problems. The few missing Teflon  $\text{NH}_4^+$  and cation concentrations were caused because those samples were incorrectly extracted for ion chromatographic analysis. A corrective action was developed to avoid this problem. The corrective action was to physically separate the extraction areas.

### ***Continuous Measurements and Filter Concentrations***

Tables 3 and 4 list data quality indicators (DQI) in terms of precision and accuracy objectives for continuous and analytical parameters for CASTNet (Harding ESE, 2002b). The primary assessment for overall precision is made by calculating the difference between simultaneous measurements taken from separate instruments at collocated sites. Currently, collocated sites are situated at Mackville, KY (MCK131) and Rocky Mountain National Park, CO (ROM206/ROM406). The two sites at Rocky Mountain National Park are operated independently. ROM206 is operated on behalf of the U. S. Environmental Protection Agency and ROM406 on behalf of the National Park Service. The ROM406 continuous measurements have been validated at Level II, while the ROM206 data are validated at Level I. In any event, precision statistics have been calculated for the  $\text{O}_3$  measurements. The  $\text{O}_3$  precision data are presented in Table 5. The mean absolute relative percent difference (MARPD) of 4.16 percent meets the precision goal of 10 percent.

Results of the precision of collocated filter pack sampling measurements during second quarter 2002 at MCK131 and ROM206/406 are provided in Table 6. Data from MCK131 and MCK231, which is the collocated site, are currently validated at Level I (Table 1). Precision statistics are acceptable for only two parameters ( $\text{Na}^+$  and  $\text{K}^+$ ), but, again, the MCK131/231 data are at Level I and may change during Level II validation procedures. The measurements from ROM206/406 indicate that all but three parameters ( $\text{NO}_3^-$ ,  $\text{HNO}_3$ , and  $\text{SO}_2$ ) met the precision criteria. The ROM206/406 data represent the fourth set of results from this site and are considered reasonable. These data will be analyzed further and reported in subsequent quarterly reports.

Table 7 presents laboratory QC results for second quarter filter pack sampling. Laboratory precision and accuracy statistics for filter pack analytes were within acceptance criteria.

### ***Nephelometer Data***

Nephelometer precision is estimated by calculating the relative uncertainty of the data based on operator-initiated zero/span calibration checks. The precision objective is  $\pm 15\%$ . The precision results for second quarter 2002 are presented in Table 8. The precision results are acceptable. The nephelometer at Quaker City, OH (QAK572) was replaced by an Interagency Monitoring of Protected Visual Environments (IMPROVE) system on March 26, 2002. The nephelometer at Cadiz, KY (CDZ171) was discontinued in August 2002. Consequently, nephelometer measurements are no longer taken by CASTNet. This subsection will be eliminated from subsequent quarterly reports.

## References

Harding ESE, Inc. (Harding ESE) 2002a. *Clean Air Status and Trends Network (CASTNet) 2000 Annual Report*. Prepared for U.S. Environmental Protection Agency (EPA). Contract No. 68-D-98-112. Gainesville, FL.

Harding ESE, Inc. (Harding ESE) 2002b. *Clean Air Status and Trends Network (CASTNet) Quality Assurance Project Plan*. Prepared for U.S. Environmental Protection Agency (EPA). Contract No. 68-D-98-112. Gainesville, FL.





## **Tables**



**Table 1.** CASTNet Sites Validated at Level I and Level II for Data Presented in the Second Quarter 2002 Report

Level I Sites				Level II Sites	
ABT147	CND125	KNZ184	ROM206	ACA416	MOR409
ALH157	CNT169	LRL117	SAL133	BBE401	NCS415
ANA115	COW137	LYE145	SND152	CAN407	OLY421
ARE128	CTH110	LYK123	SPD111	CHA467	PIN414
ASH135	CVL151	MCK131	STK138	DEN417	POF425
BEL116	DCP114	MCK231	SUM156	DEV412	ROM406
BFT142	EGB181	MKG113	UVL124	EVE419	SEK402
BVL130	ESP127	OXF122	VIN140	GLR468	SHN418
BWR139	GAS153	PAR107	VPI120	GRB411	THR422
CAD150	GTH161	PED108	WSP144	GRC474	VII423
CAT175	HOW132	PND165	WST109	GRS420	VOY413
CDR119	HOX148	PNF126		HVT424	YEL408
CDZ171	HWF187	PRK134		JOT403	YOS404
CHE185	IRL141	PSU106		LAV410	
CKT136	KEF112	QAK172		MEV405	

**Table 2.** Percent Data Completeness for Filter Concentrations for Second Quarter 2002 (1 of 2)

Site ID	Teflon <sup>®</sup> SO <sub>4</sub> <sup>2-</sup>	Teflon <sup>®</sup> NO <sub>3</sub> <sup>-</sup>	Teflon <sup>®</sup> NH <sub>4</sub> <sup>+</sup>	Teflon <sup>®</sup> Minor Cations	Nylon HNO <sub>3</sub>	Nylon SO <sub>4</sub> <sup>2-</sup>	Whatman SO <sub>2</sub>
ABT147	92.3	92.3	92.3	92.3	92.3	92.3	92.3
ACA416	100.0	100.0	100.0	92.3	100.0	100.0	100.0
ALH157	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ANA115	100.0	100.0	92.3	92.3	100.0	100.0	100.0
ARE128	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ASH135	100.0	100.0	100.0	100.0	100.0	100.0	100.0
BBE401	100.0	100.0	100.0	100.0	100.0	100.0	100.0
BEL116	100.0	100.0	100.0	100.0	100.0	100.0	100.0
BFT142	100.0	100.0	100.0	100.0	100.0	100.0	100.0
BVL130	100.0	100.0	100.0	100.0	100.0	100.0	100.0
BWR139	92.3	92.3	92.3	92.3	92.3	92.3	92.3
CAD150	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CAN407	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CAT175	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CDR119	92.3	92.3	92.3	92.3	92.3	92.3	92.3
CDZ171	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CHA467	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CHE185	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CKT136	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CND125	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CNT169	100.0	100.0	100.0	100.0	100.0	100.0	100.0
COW137	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CTH110	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CVL151	100.0	100.0	100.0	100.0	100.0	100.0	100.0
DCP114	100.0	100.0	100.0	100.0	100.0	100.0	100.0
DEN417	100.0	100.0	100.0	100.0	100.0	100.0	100.0
DEV412	100.0	100.0	100.0	100.0	100.0	100.0	100.0
EGB181	92.3	92.3	84.6	84.6	92.3	92.3	92.3
ESP127	92.3	92.3	92.3	92.3	92.3	92.3	92.3
EVE419	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GAS153	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GLR468	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GRB411	92.3	92.3	92.3	92.3	92.3	92.3	92.3
GRC474	100.0	100.0	92.3	92.3	100.0	100.0	100.0
GRS420	100.0	100.0	100.0	100.0	100.0	100.0	100.0
GTH161	100.0	100.0	92.3	92.3	100.0	100.0	100.0
HOW132	100.0	100.0	100.0	100.0	100.0	100.0	100.0
HOX148	100.0	100.0	100.0	100.0	100.0	100.0	100.0
HVT424	100.0	100.0	100.0	100.0	100.0	100.0	100.0
HWF187	75.0	75.0	75.0	75.0	75.0	75.0	75.0
IRL141	100.0	100.0	100.0	100.0	100.0	100.0	100.0
JOT403	100.0	100.0	100.0	100.0	100.0	100.0	100.0
KEF112	100.0	100.0	92.3	92.3	100.0	100.0	100.0
KNZ184	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LAV410	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LRL117	100.0	100.0	100.0	100.0	100.0	100.0	100.0
LYE145	92.3	92.3	84.6	84.6	92.3	92.3	92.3
LYK123	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MCK131	100.0	100.0	100.0	100.0	100.0	100.0	100.0

**Table 2.** Percent Data Completeness for Filter Concentrations for Second Quarter 2002 (2 of 2)

Site ID	Teflon <sup>®</sup> SO <sub>4</sub> <sup>2-</sup>	Teflon <sup>®</sup> NO <sub>3</sub> <sup>-</sup>	Teflon <sup>®</sup> NH <sub>4</sub> <sup>+</sup>	Teflon <sup>®</sup> Minor Cations	Nylon HNO <sub>3</sub>	Nylon SO <sub>4</sub> <sup>2-</sup>	Whatman SO <sub>2</sub>
MCK231	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MEV405	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MKG113	100.0	100.0	100.0	100.0	100.0	100.0	100.0
MOR409	92.3	92.3	92.3	92.3	92.3	92.3	92.3
NCS415	92.3	92.3	92.3	92.3	92.3	92.3	92.3
OLY421	100.0	100.0	100.0	100.0	100.0	100.0	100.0
OXF122	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PAR107	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PED108	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIN414	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PND165	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PNF126	100.0	100.0	100.0	100.0	100.0	100.0	100.0
POF425	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PRK134	100.0	100.0	100.0	100.0	100.0	100.0	100.0
PSU106	100.0	100.0	100.0	100.0	100.0	100.0	100.0
QAK172	100.0	100.0	92.3	92.3	100.0	100.0	100.0
ROM206	100.0	100.0	100.0	100.0	100.0	100.0	100.0
ROM406	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SAL133	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SEK402	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SHN418	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SND152	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SPD111	100.0	100.0	100.0	100.0	100.0	100.0	100.0
STK138	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SUM156	100.0	100.0	100.0	100.0	100.0	100.0	100.0
THR422	84.6	84.6	84.6	84.6	84.6	84.6	84.6
UVL124	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VII423	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VIN140	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VOY413	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VPI120	100.0	100.0	100.0	100.0	100.0	100.0	100.0
WSP144	100.0	100.0	100.0	100.0	100.0	100.0	100.0
WST109	100.0	100.0	100.0	100.0	100.0	100.0	100.0
YEL408	92.3	92.3	92.3	92.3	92.3	92.3	92.3
YOS404	100.0	100.0	100.0	100.0	100.0	100.0	100.0

**Table 3.** Data Quality Indicators for CASTNet Continuous Measurements

Measurement Parameter	Method	Criteria <sup>1</sup>	
		Precision	Accuracy
Wind Speed	Anemometer	± 0.5 m/s	The greater of ± 0.5 m/s for winds < 5 m/s or ± 5% for winds ≥ 5 m/s
Wind Direction	Wind Vane	± 5°	± 5°
Sigma Theta	Wind Vane	Undefined	Undefined
Relative Humidity	Thin Film Capacitor	± 10% (of full scale)	± 5%, rel. hum. > 85% ± 20%, rel. hum. ≤ 85%
Solar Radiation	Pyranometer	± 10% (of reading taken at local noon)	± 10%
Precipitation	Tipping Bucket Rain Gauge	± 10% (of reading)	± 0.05 inch <sup>2</sup>
Ambient Temperature	Platinum RTD	± 1.0°C	± 0.5°C
Delta Temperature	Platinum RTD	± 0.5°C	± 0.5°C
O <sub>3</sub>	UV Absorbance	± 10% (of reading)	± 10%
Filter Pack Flow	Mass Flow Controller	± 10%	± 5%
Surface Wetness	Conductivity Bridge	Undefined	Undefined
Light Scattering	Nephelometer	± 15%	Undefined <sup>3</sup>

**Note:** °C = degrees Celsius  
m/s = meters per second  
rel. hum. = relative humidity  
RTD = resistance-temperature device  
UV = ultraviolet

<sup>1</sup> Precision criteria apply to collocated instruments and accuracy criteria apply to calibration of instruments.

<sup>2</sup> For target value of 0.50 inch.

<sup>3</sup> Nephelometer is replaced annually with a laboratory certified instrument.

**Table 4.** Data Quality Indicators<sup>1</sup> for CASTNet Laboratory Measurements

Analyte	Medium	Method	Precision <sup>2</sup> (MARPD)	Accuracy (%)	Nominal Detection Limits
Ammonium (NH <sub>4</sub> <sup>+</sup> )	F	Automated colorimetry	10	90 - 110	0.02 mg-N/L
Sodium (Na <sup>+</sup> )	F	ICAP-AE	10	90 - 110	0.005 mg/L
Potassium (K <sup>+</sup> )	F	ICAP-AE	10	90 - 110	0.005 mg/L
Magnesium (Mg <sup>2+</sup> )	F	ICAP-AE	10	90 - 110	0.003 mg/L
Calcium (Ca <sup>2+</sup> )	F	ICAP-AE	10	90 - 110	0.003 mg/L
Nitrate (NO <sub>3</sub> <sup>-</sup> )	F	Ion chromatography	5	95 - 105	0.008 mg-N/L
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	F	Ion chromatography	5	95 - 105	0.04 mg/L

**Note:** <sup>1</sup> Visibility aerosol sampling was discontinued at the end of 2001.

<sup>2</sup> This column lists precision goals for both network precision calculated from collocated filter samples and laboratory precision based on replicate samples.

F = filter pack samples  
 ICAP-AE = inductively coupled argon plasma-atomic emission.  
 MARPD = mean absolute relative percent difference  
 N = nitrogen

For more information on analytical methods and associated precision and accuracy criteria, see the CASTNet Quality Assurance Project Plan (Harding ESE, 2002b).

**Table 5.** Ozone Precision Statistics for ROM206/406

Sampling Period	ROM206 (Conc. ppb)	ROM406 (Conc. ppb)	MAD (ppb)	MARPD (%)	Composite Completeness
First Quarter 2002	45.7	47.0	1.4	2.93	91.9%
Second Quarter 2002	53.0	55.2	2.2	4.16	94.3%
Third Quarter 2002					
Fourth Quarter 2002					

**Note:** Conc. ppb = concentrations in parts per billion  
 MAD = mean absolute difference  
 MARPD = mean absolute relative percent difference

**Table 6.** Precision (MARPD) for Filter Pack Data Via Collocated Sampling During Second Quarter 2002

Statistic	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	HNO <sub>3</sub>	SO <sub>2</sub>	Total NO <sub>3</sub> <sup>-</sup>
<b>MCK131/231</b>										
$\bar{X}$ (μg/m <sup>3</sup> )	5.41	0.57	1.80	0.26	0.05	0.15	0.09	2.80	4.63	3.33
$\bar{Y}$ (μg/m <sup>3</sup> )	5.11	0.52	1.81	0.24	0.04	0.14	0.08	2.46	4.20	3.07
MAD	0.40	0.08	0.24	0.04	0.01	0.02	0.01	0.44	0.52	0.50
MARPD	6.88	16.08	19.15	13.31	12.00	8.88	8.90	11.50	9.30	11.16
<b>ROM206/406</b>										
$\bar{X}$ (μg/m <sup>3</sup> )	1.10	0.74	0.44	0.39	0.05	0.06	0.06	0.90	0.60	1.62
$\bar{Y}$ (μg/m <sup>3</sup> )	1.07	0.74	0.44	0.37	0.05	0.06	0.06	0.88	0.62	1.61
MAD	0.04	0.06	0.02	0.01	0.00	0.00	0.00	0.06	0.06	0.07
MARPD	3.67	6.67	4.76	3.54	5.57	9.51	7.99	7.17	10.17	4.00

**Note:** MAD = mean absolute difference

MARPD = mean absolute relative percent difference

$\bar{X}$  = quarterly mean for primary sampler

$\bar{Y}$  = quarterly mean for collocated sampler



**Table 7.** Filter Pack QC Summary for Second Quarter 2002

Filter Type	Parameter	Reference Sample <sup>1</sup> Recovery (%R)		Continuing Verification Samples (%R)		In-Run Replicate <sup>2</sup> Percent Difference	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Teflon <sup>®</sup>	SO <sub>4</sub> <sup>2-</sup>	100.07	1.73	99.31	1.27	0.40	0.43
	NO <sub>3</sub> <sup>-</sup>	98.45	1.99	98.73	1.35	1.00	1.10
	NH <sub>4</sub> <sup>+</sup>	102.04	2.13	98.96	1.71	1.01	2.06
	Ca <sup>2+</sup>	101.90	5.30	100.43	1.06	1.09	1.83
	Mg <sup>2+</sup>	101.41	0.87	99.53	0.74	1.13	1.16
	Na <sup>+</sup>	95.64	1.10	99.70	0.77	0.81	0.87
	K <sup>+</sup>	99.52	2.01	99.93	0.64	1.69	1.75
Nylon	SO <sub>4</sub> <sup>2-</sup>	98.44	1.70	99.31	1.13	3.05	4.19
	NO <sub>3</sub> <sup>-</sup>	98.70	1.51	98.87	1.24	1.11	1.46
Whatman	SO <sub>4</sub> <sup>2-</sup>	100.52	0.97	98.47	0.94	4.78	8.36

**Note:** %R = percent recovery  
Std. Dev. = standard deviation

<sup>1</sup> Results of reference sample analyses provide accuracy estimates.

<sup>2</sup> Results of replicate analyses provide precision estimates.

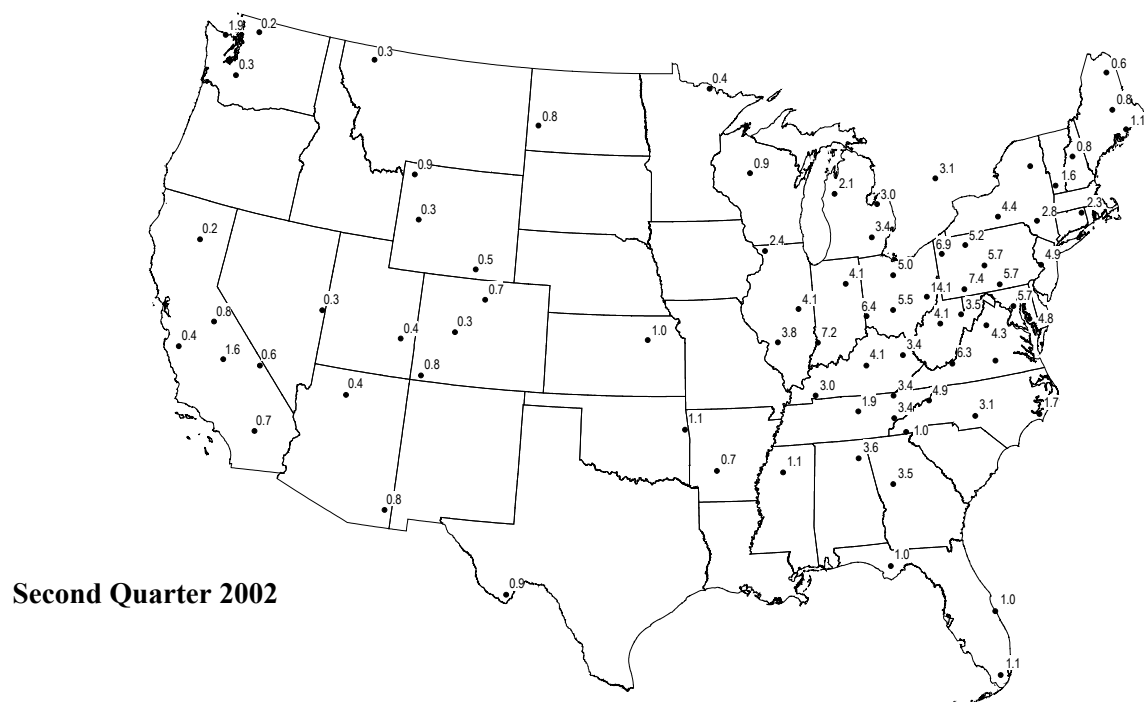
**Table 8.** Quarterly Precision Results for Nephelometer Data

Sampling Period	CDZ571	QAK572
First Quarter 2002	5%	12%
Second Quarter 2002	12%	N/A
Third Quarter 2002		
Fourth Quarter 2002		

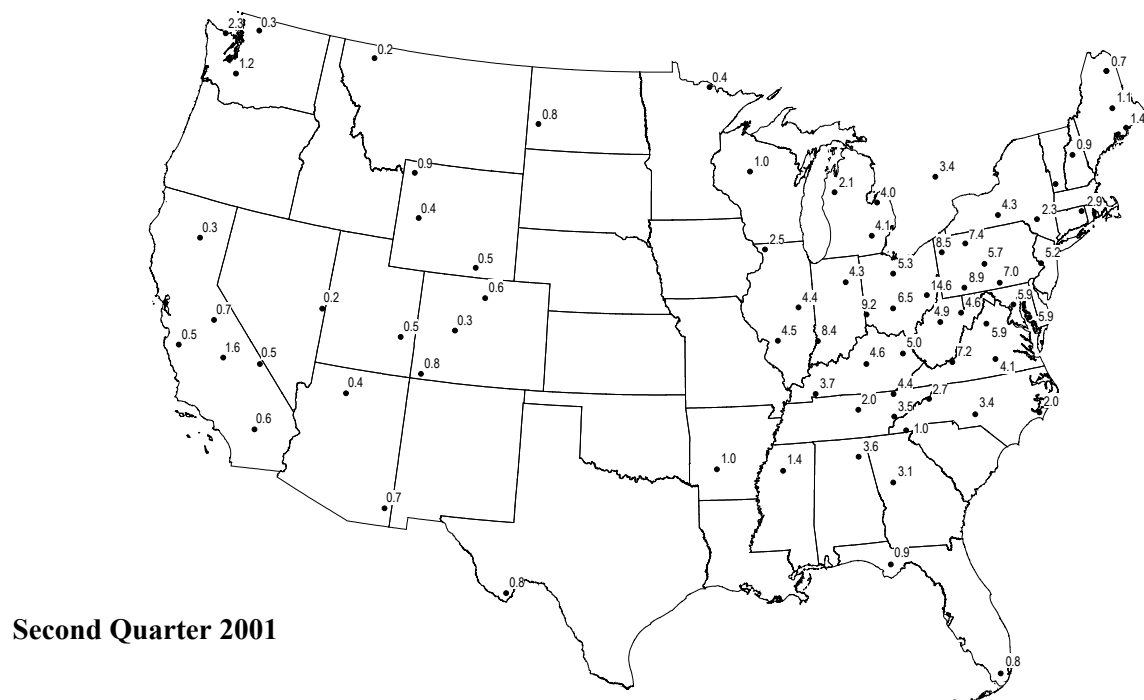
**Note:** The operation of the nephelometer at QAK572 was transferred to the IMPROVE network on March 26, 2002.



## **Figures**



Second Quarter 2002



Second Quarter 2001

Figure 1a. Quarterly Mean SO<sub>2</sub> Concentrations (µg/m<sup>3</sup>)

**Figure 1b.** Quarterly Mean SO<sub>2</sub> Concentration Differences (percent)

Second Quarter 2002



Second Quarter 2001

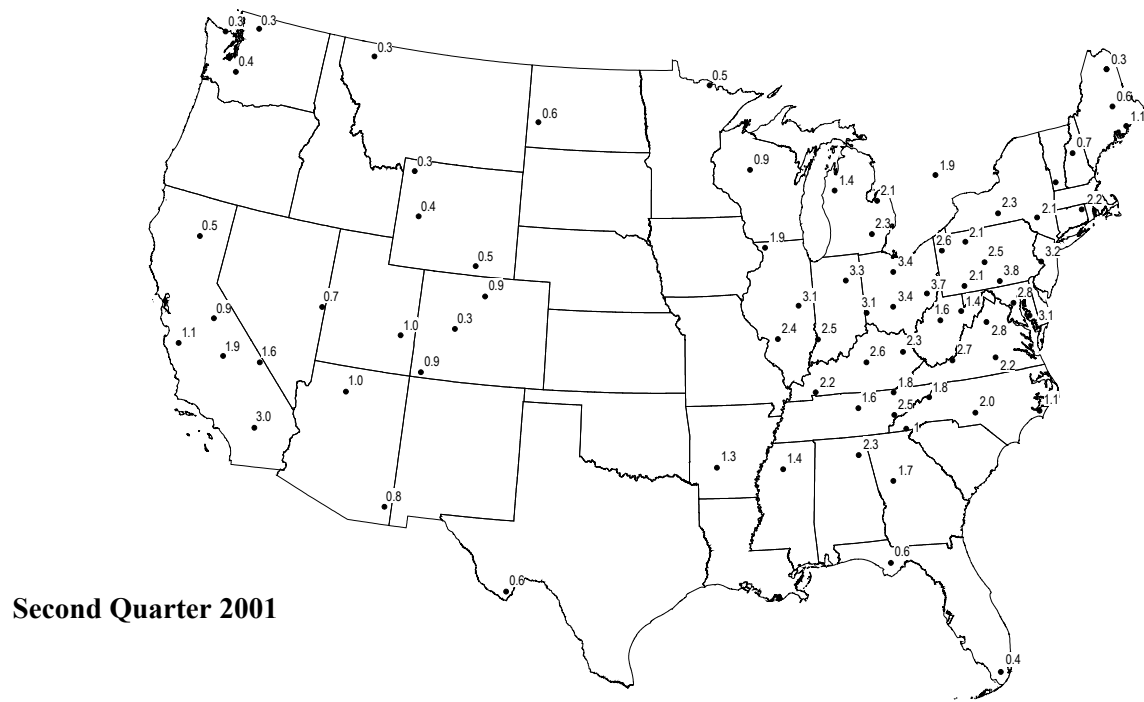
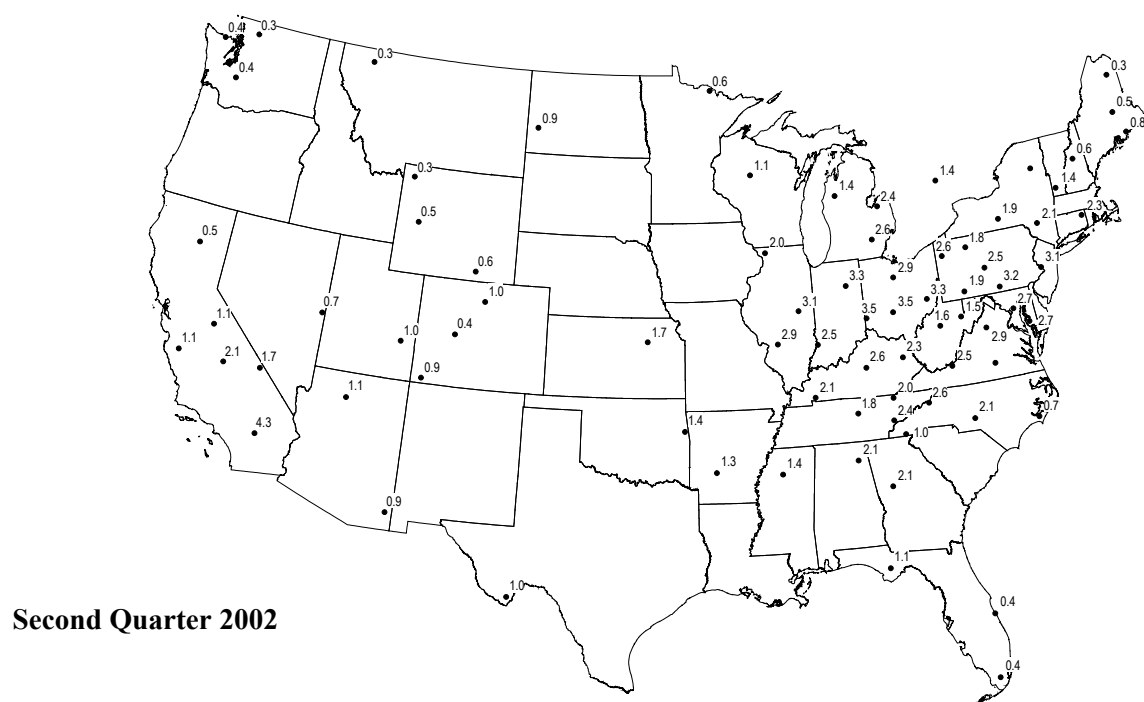


Figure 2a. Quarterly Mean  $\text{SO}_2$  Concentrations ( $\mu\text{g}/\text{m}^3$ )



**Percent Difference Between  
Second Quarter 2002 and  
Second Quarter 2001**

**Figure 2b. Quarterly Mean  $\text{SO}_4^{2-}$  Concentration Differences (percent)**



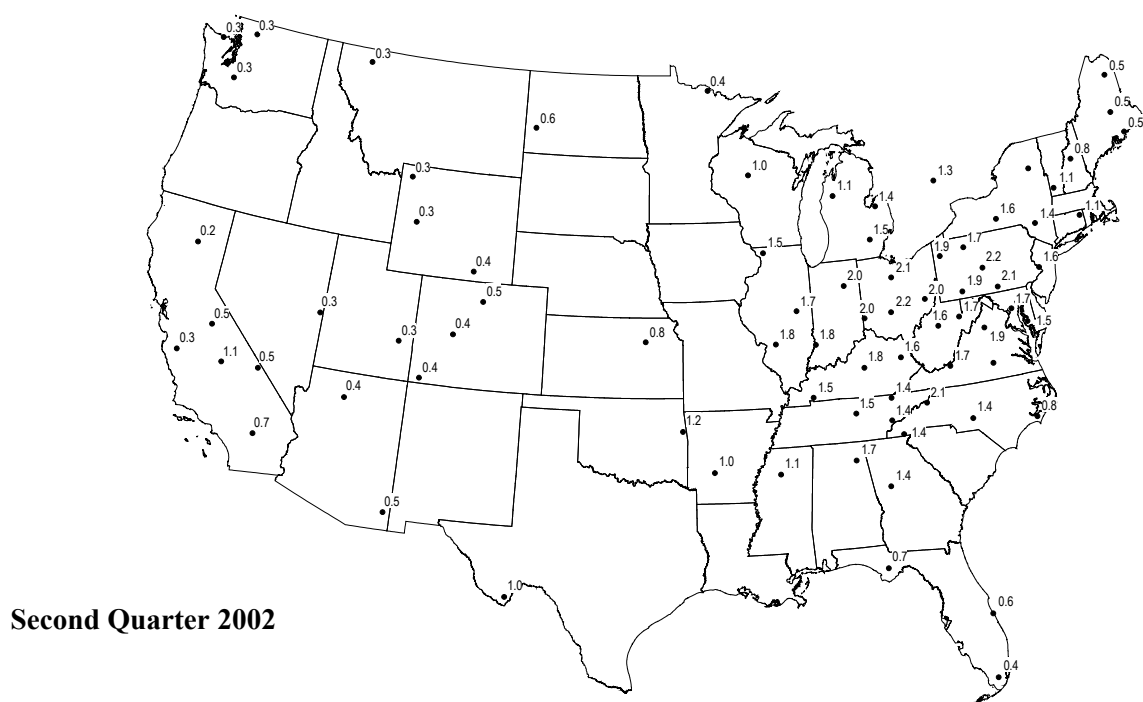
**Figure 3a.** Quarterly Mean  $\text{HNO}_3$  Concentrations ( $\mu\text{g}/\text{m}^3$ )



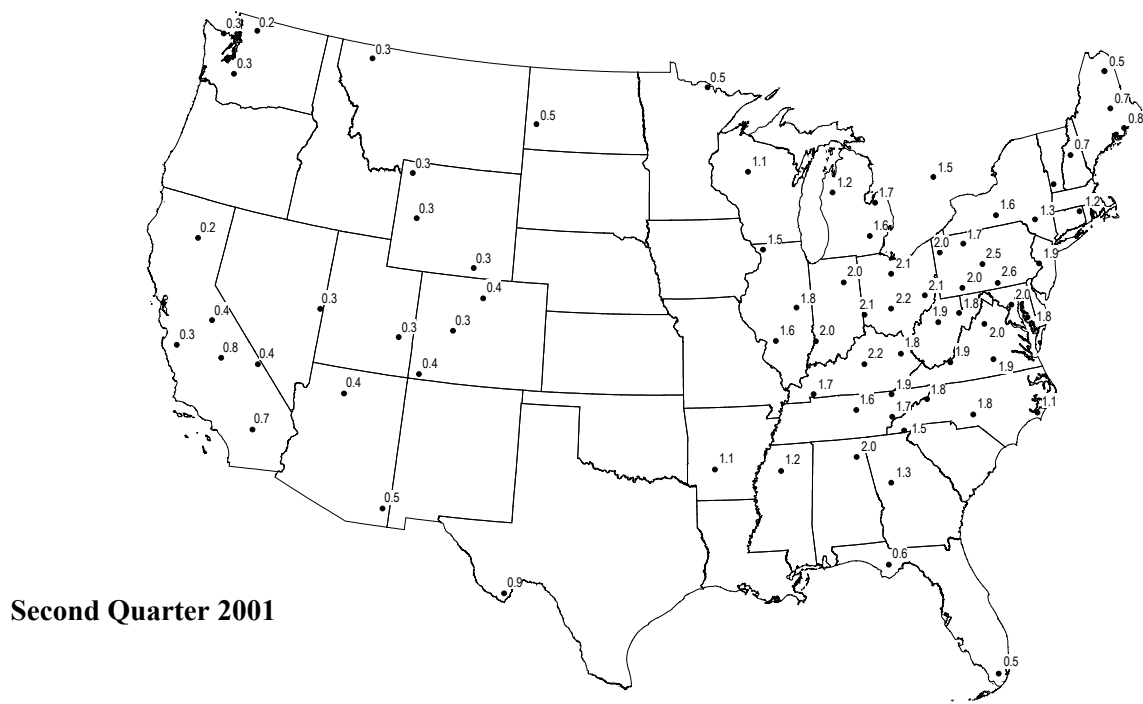


**Percent Difference Between  
Second Quarter 2002 and  
Second Quarter 2001**

**Figure 3b. Quarterly Mean HNO<sub>3</sub> Concentration Differences (percent)**



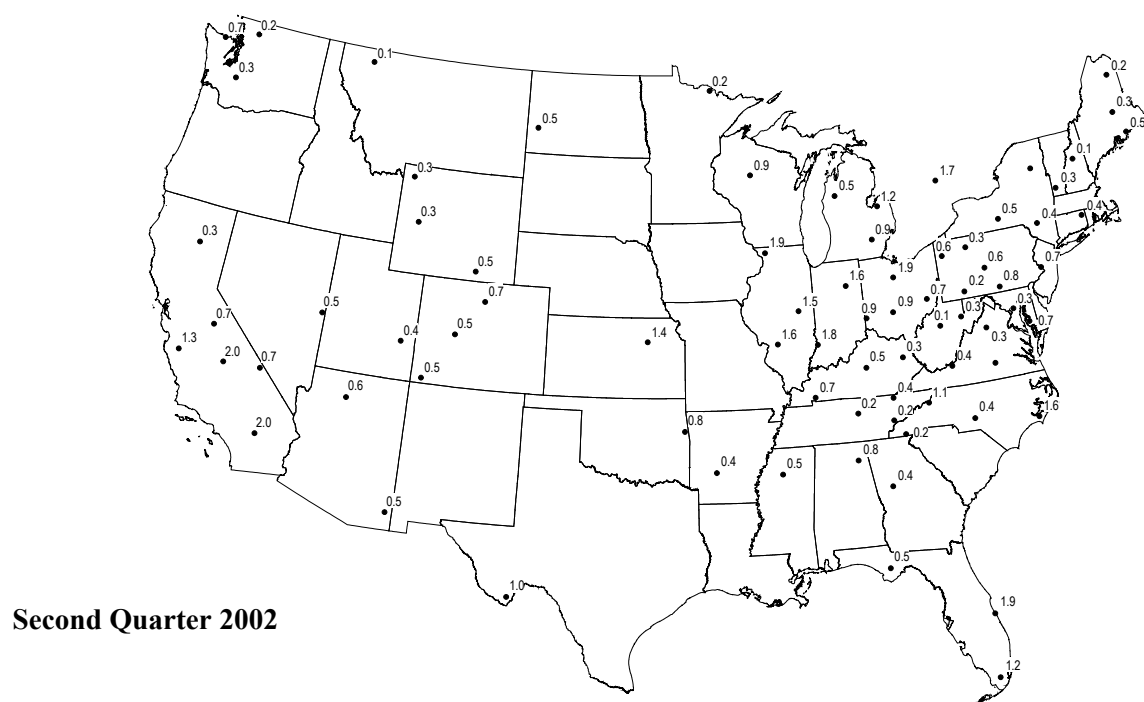
## Second Quarter 2002



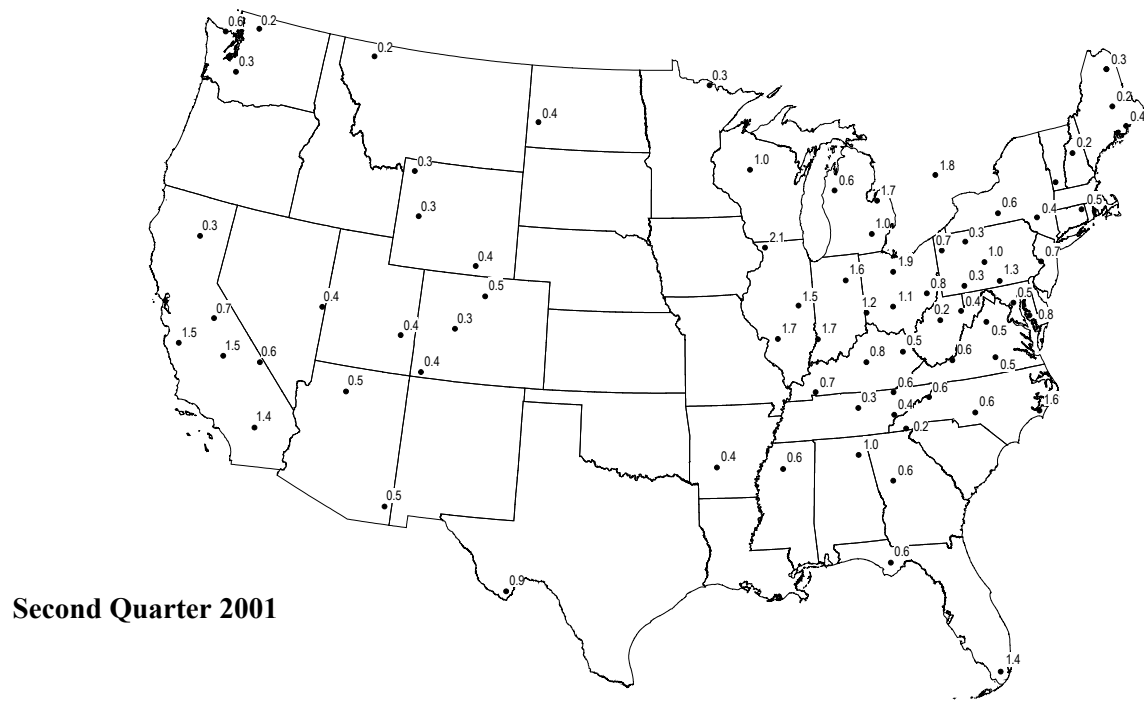
## Second Quarter 2001

**Figure 4a.** Quarterly Mean  $\text{NH}_4^+$  Concentrations ( $\mu\text{g}/\text{m}^3$ )

Harding ESE, Inc.



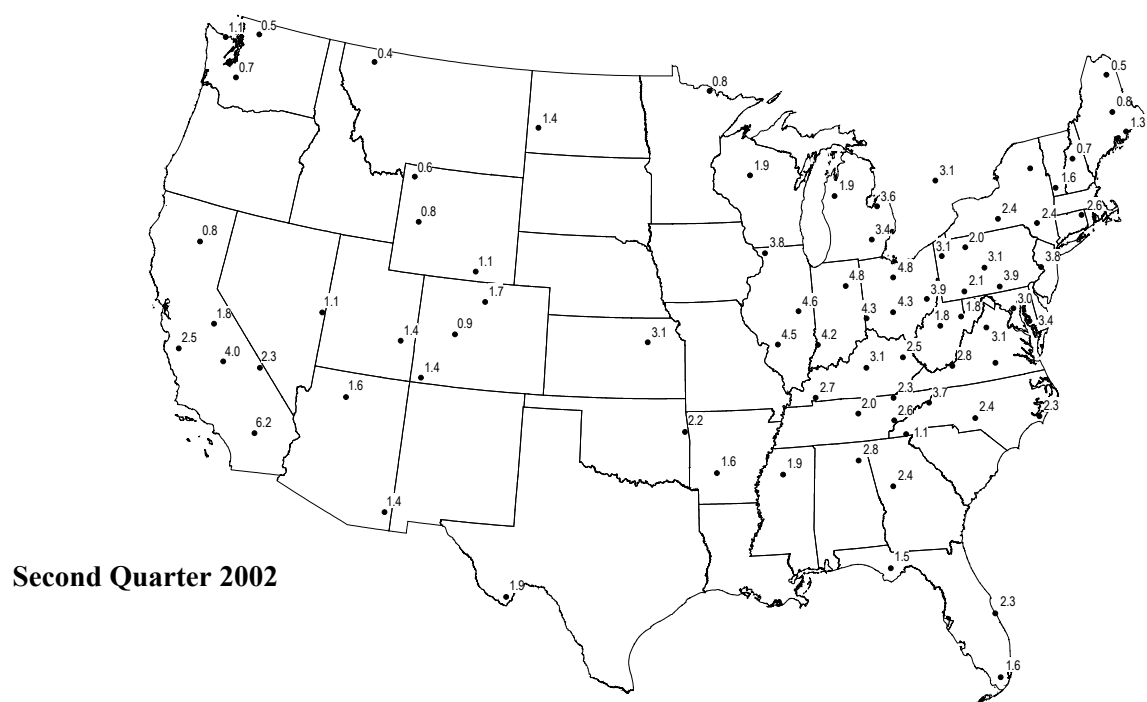
Second Quarter 2002



Second Quarter 2001

**Figure 5a.** Quarterly Mean  $\text{NO}_3$  Concentrations ( $\mu\text{g}/\text{m}^3$ )

**Figure 5b.** Quarterly Mean NO<sub>3</sub><sup>-</sup> Concentration Differences (percent)



Second Quarter 2002



Second Quarter 2001

**Figure 6a.** Quarterly Mean Total  $\text{NO}_3$  Concentrations ( $\mu\text{g}/\text{m}^3$ )

Harding ESE, Inc.



**Figure 7.** Second Quarter Mean  $\text{Ca}^{2+}$  Concentrations ( $\mu\text{g}/\text{m}^3$ ) for 2002



**Figure 8.** Second Quarter Mean  $\text{K}^+$  Concentrations ( $\mu\text{g}/\text{m}^3$ ) for 2002

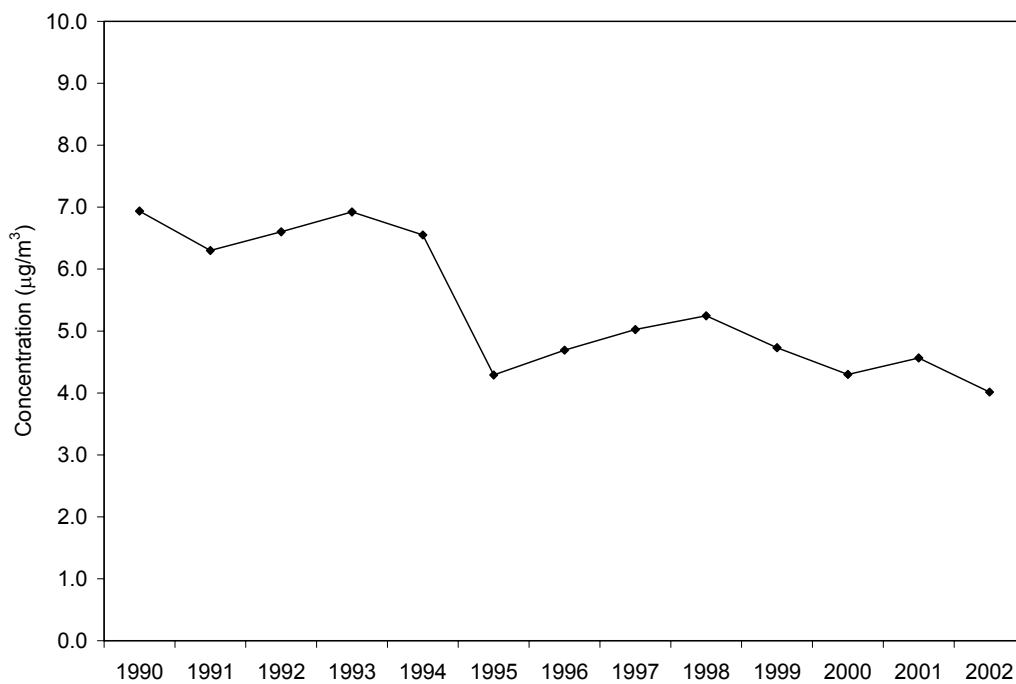




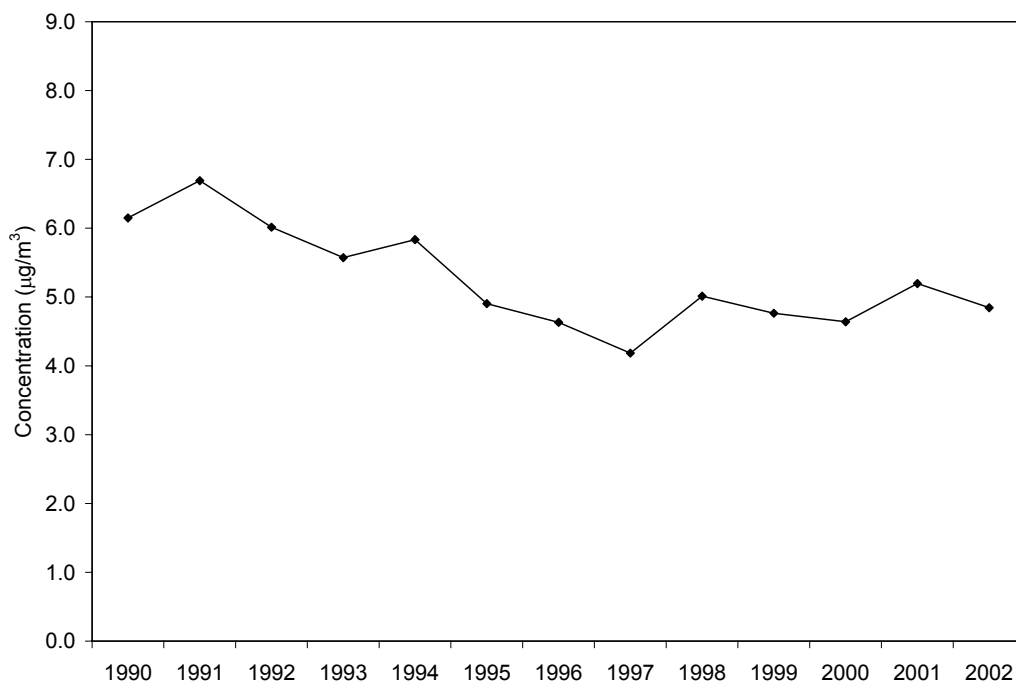
**Figure 9.** Second Quarter Mean  $\text{Mg}^{2+}$  Concentrations ( $\mu\text{g}/\text{m}^3$ ) for 2002



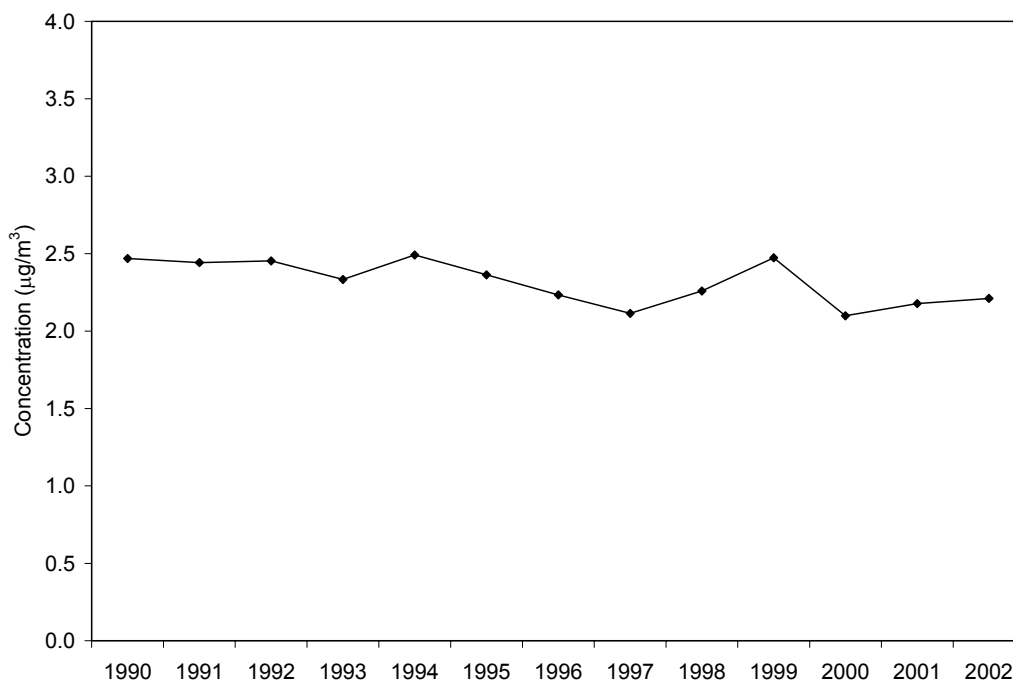
**Figure 10.** Second Quarter Mean  $\text{Na}^+$  Concentrations ( $\mu\text{g}/\text{m}^3$ ) for 2002



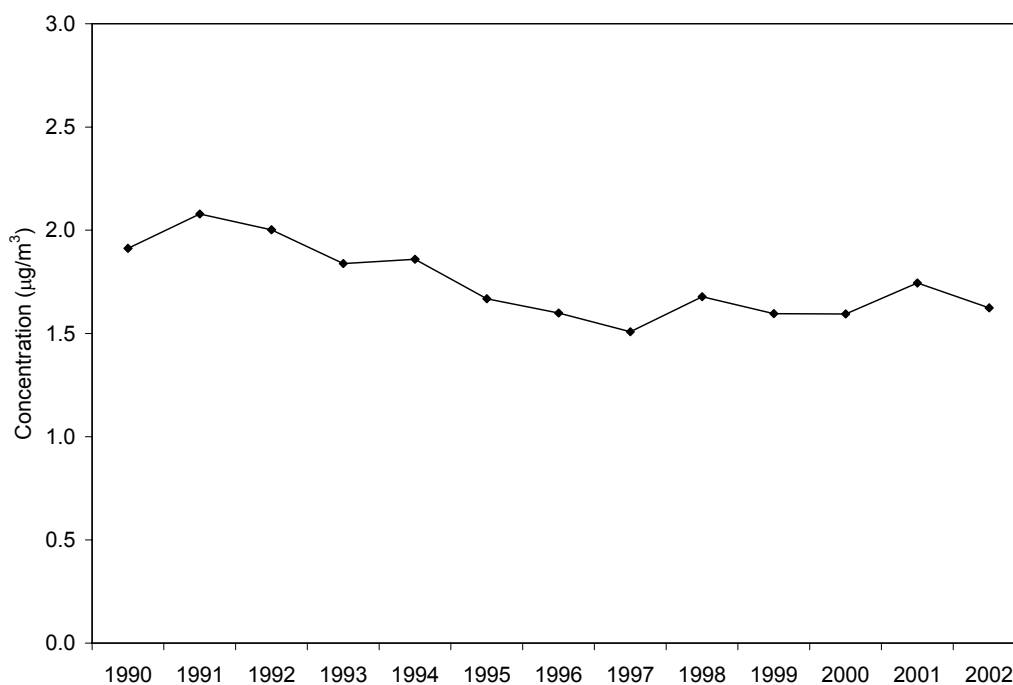
**Figure 11.** Trend in Composite Second Quarter Mean SO<sub>2</sub> Concentrations



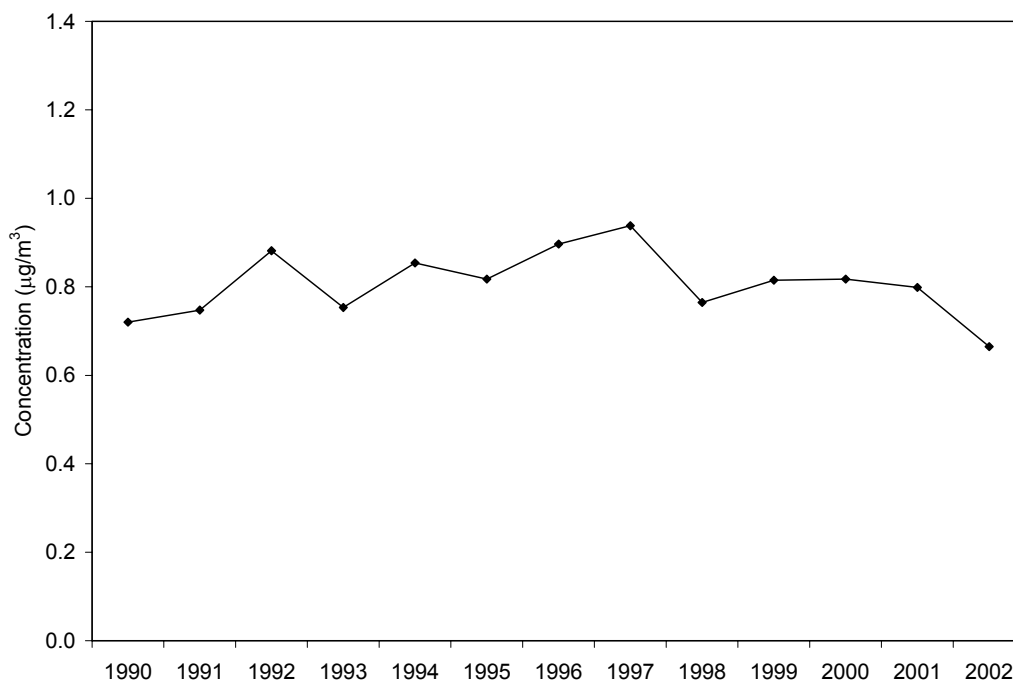
**Figure 12.** Trend in Composite Second Quarter Mean SO<sub>4</sub><sup>2-</sup> Concentrations



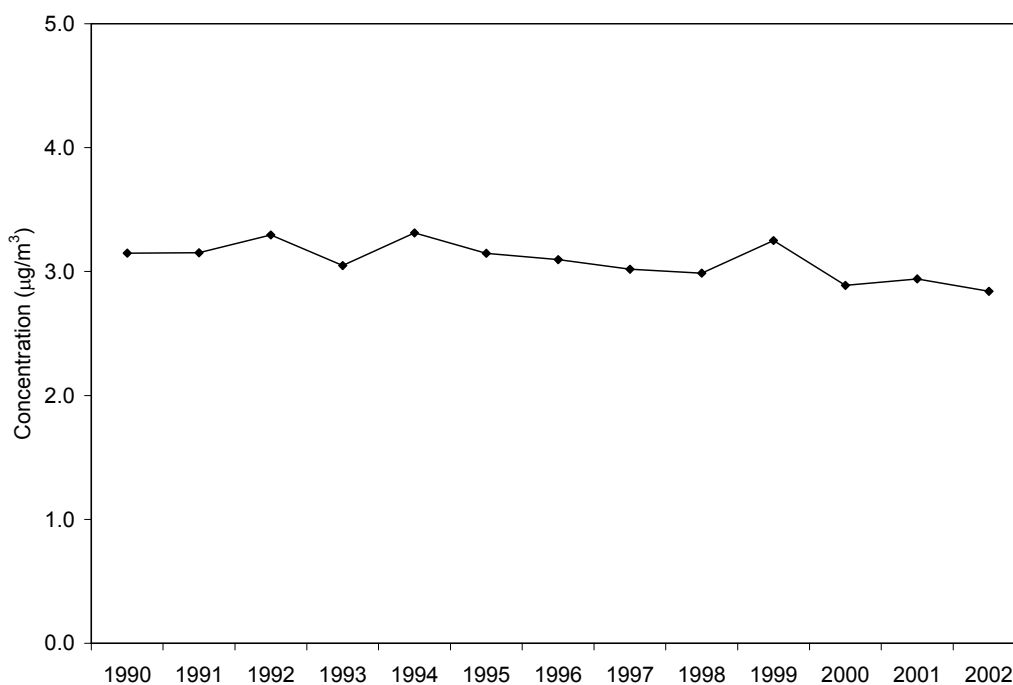
**Figure 13.** Trend in Composite Second Quarter Mean  $\text{HNO}_3$  Concentrations



**Figure 14.** Trend in Composite Second Quarter Mean  $\text{NH}_4^+$  Concentrations



**Figure 15.** Trend in Composite Second Quarter Mean  $\text{NO}_3^-$  Concentrations



**Figure 16.** Trend in Composite Second Quarter Mean Total  $\text{NO}_3^-$  Concentrations



**Figure 17.** Number of Days with Hourly O<sub>3</sub> Concentrations Greater Than or Equal to 125 ppb Through Second Quarter 2002



**Figure 18.** Fourth Highest Daily Maximum Eight-Hour O<sub>3</sub> Concentrations Through Second Quarter 2002